



(22) Date de dépôt/Filing Date: 2009/08/07

(41) Mise à la disp. pub./Open to Public Insp.: 2010/02/08

(45) Date de délivrance/Issue Date: 2014/02/11

(30) Priorité/Priority: 2008/08/08 (US12/188,680)

(51) Cl.Int./Int.Cl. *F16K 24/06* (2006.01),
E03C 1/295 (2006.01), *F16K 15/14* (2006.01),
F16K 7/12 (2006.01), *F16L 55/07* (2006.01)

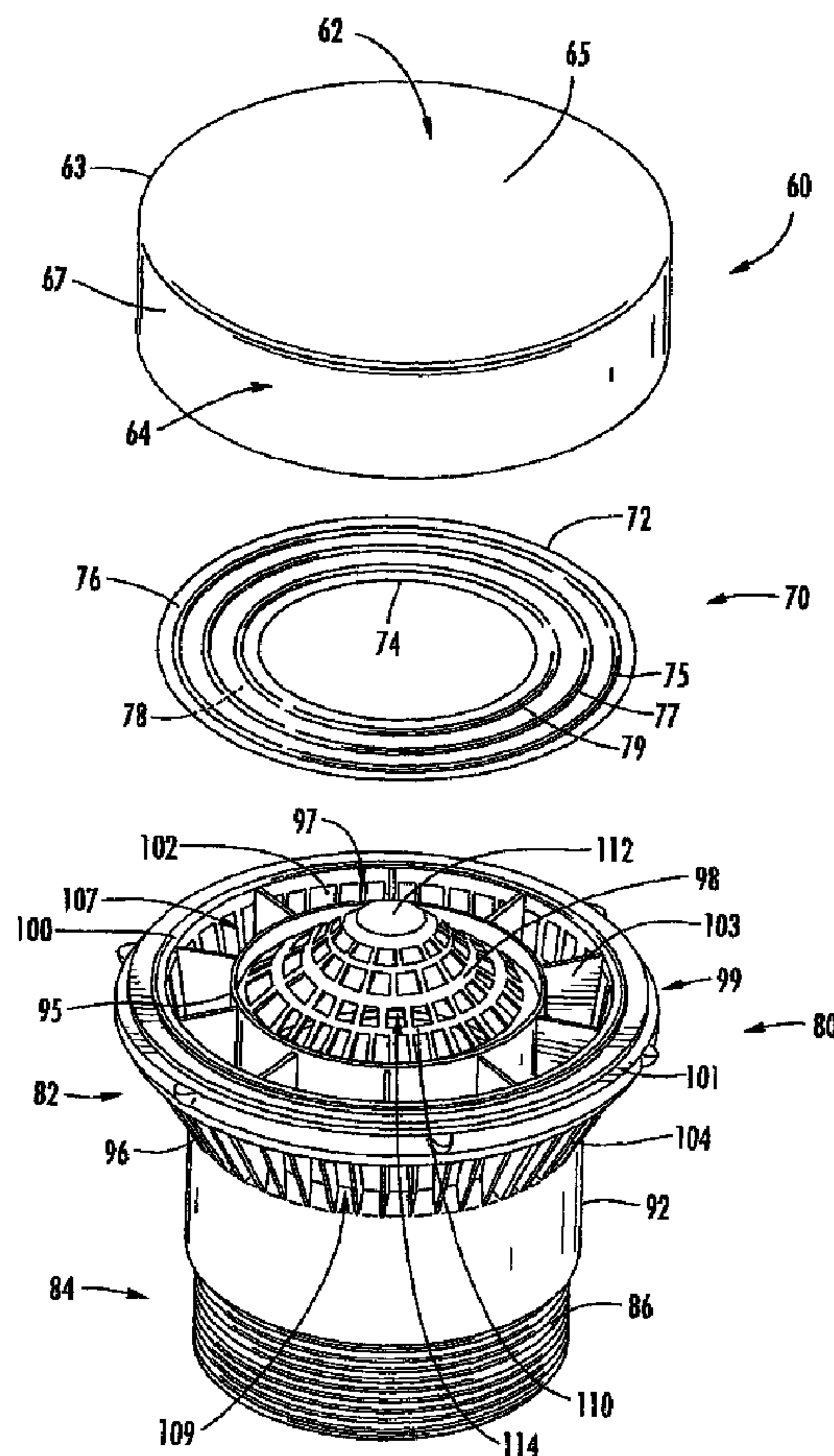
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(54) Titre : SOUPAPE D'ADMISSION D'AIR

(54) Title: AIR ADMITTANCE VALVE



(57) Abrégé/Abstract:

An air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment. In general, the air admittance valve includes a main body, inner and outer valve seats, a flexible sealing element, and

(57) **Abrégé(suite)/Abstract(continued):**

a lid. The inner and outer valve seats define at least one vent opening between valve seats that is configured, when open, to communicate with the ambient environment. The flexible sealing element is devoid of a rigidifying structure, is configured to move to and from a closed position and an open position, and defines an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces. At least one of the lid or the main body further comprises one or more guiding elements that define one or more guiding surfaces configured to guide the sealing element to and from the closed position and the open position.

ABSTRACT OF THE DISCLOSURE

An air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment. In general, the air admittance valve includes a main body, inner and outer valve seats, a flexible sealing element, and a lid. The inner and outer valve seats define at least one vent opening between valve seats that is configured, when open, to communicate with the ambient environment. The flexible sealing element is devoid of a rigidifying structure, is configured to move to and from a closed position and an open position, and defines an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces. At least one of the lid or the main body further comprises one or more guiding elements that define one or more guiding surfaces configured to guide the sealing element to and from the closed position and the open position.

AIR ADMITTANCE VALVE

FIELD OF THE INVENTION

The present invention relates to air ventilation devices for use in pipe systems, and, more particularly, to air admittance valves used to vent pipe systems to the ambient environment.

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BACKGROUND OF THE INVENTION

In general, air admittance valves are used in plumbing systems as an alternative to vent systems that require venting through a complicated pipe system and/or rooftop vent system. Air admittance valves are one-way mechanical valves that may be located in a ventilated space to alleviate a need to connect to a central vertical vent (or to provide a separate vertical vent) that passes through the roof of a structure. **FIG. 1** shows a typical application of an air admittance valve. Air admittance valves are normally closed, but open during a negative pressure condition, such as when wastewater is released. This allows air to enter the plumbing system and facilitate drainage. Once the flow of the wastewater ceases, the valve closes and remains closed until another negative pressure condition occurs. In such a manner, odors are prevented from escaping from the vent system.

Many air admittance valves rely on gravity to close the valve once a negative pressure condition ceases. Such air admittance valves usually include sealing members that are constructed of multiple components. Typically, a rigid plate or frame structure is used to carry a thin flexible sealing member to and from closed and open positions. In many instances the thin flexible sealing member is bonded, stretched across, or otherwise fixed to the rigid frame structure. An example of such a design is described in U.S. Patent No. 4,535,807.

These multipart constructions, however, are difficult and expensive to manufacture. Additionally, any detachment of the sealing member from the rigid frame structure is likely to result in inferior, and in some situations, failed performance of the air admittance valve. Furthermore, in many situations the ability of the sealing member to perform the sealing function is dictated by the accuracy of the dimensions of the frame structure. For instance, frame structures that have certain discontinuities, uneven surfaces, or other dimensional aberrations may not allow the sealing members to seal the valve in the closed position.

There is a need, therefore, for an improved air admittance valve that is configured to vent pipe systems to the ambient environment. The improved air admittance valve should be simpler and less expensive to manufacture, and should also provide enhanced performance.

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BRIEF SUMMARY OF THE INVENTION

According to an aspect of the invention, there is provided an air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising: a main body having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body also defining a first chamber configured to communicate with the pipe system; inner and outer valve seats that define at least one vent opening located between the inner and outer valve seats and configured to communicate with the ambient environment; a flexible sealing element devoid of a rigidifying structure and configured to move between a closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces; and a lid configured to sealingly attach to the main body, wherein the lid further comprises one or more guiding elements that define one or more guiding surfaces configured to allow relative movement with a portion of the inner perimeter surface of the sealing element so as to guide the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and outer valve seats thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the first chamber communicates with the ambient environment through the vent opening.

A further aspect of the invention provides an air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising: a main body having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body also defining a first chamber configured to communicate with the pipe system; inner and outer valve seats that define at least one vent opening located between the inner and outer valve seats and configured to communicate with the ambient environment; a flexible, free-floating sealing element

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devoid of a rigidifying structure and configured to move between a closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces; and a lid configured to sealingly attach to the main body proximate the top portion of the main body, wherein the main body further comprises one or more guiding elements that define one or more guiding surfaces configured to allow relative movement with a portion of the inner perimeter surface of the sealing element so as to guide the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and outer valve seats thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the first chamber communicates with the ambient environment through the vent opening.

There is also provided an air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising: a main body made of a rigid material and having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body comprising substantially concentric inner and outer valve seats and at least one vent opening between the inner and outer valve seats and configured to communicate with the ambient environment, the main body also defining a main body chamber configured to communicate with the pipe system, wherein the main body comprises an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, wherein one end of the main body wall defines the inner valve seat, and wherein the main body further defines an internal communication element and an external communication element, the internal communication element extending inwardly from the inner surface of the main body wall and comprising a plurality of openings allowing communication therethrough between the main body chamber and a lid chamber, the external communication element extending outwardly and at an angle from the outer surface of the main body wall such that an end of the external

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communication element defines the outer valve seat, and wherein an external communication chamber is defined between the outer surface of the main body wall and the external communication element, the external communication element comprising a plurality of openings allowing communication therethrough between the external communication chamber and the ambient environment; a flexible ring-shaped sealing element configured to move between a closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces; and a lid made of a rigid material and configured to sealingly attach to the main body proximate the top portion of the main body, the lid comprising a top portion, and a side portion approximately perpendicular to the top portion and extending from an outer perimeter of the top portion of the lid, the top and side portions of the lid each defining inner and outer surfaces such that the inner surfaces of the lid define the lid chamber, wherein the lid further comprises a plurality of triangularly-shaped ribs extending substantially downward from the inner surface of the top portion of the lid and disposed radially about an imaginary center point such that the plurality of ribs define a plurality of guiding edges configured to engage the inner perimeter surface of the sealing element so as to guide the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and outer valve seats of the main body thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the main body chamber communicates with the ambient environment through the vent opening, the lid chamber, and the external communication chamber.

Embodiments of the present invention may address the above needs and may achieve other advantages by providing an air admittance valve configured when subjected to a negative pressure condition to

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vent a pipe system to an ambient environment. In general, the air admittance valve includes a
 5 main body, inner and outer valve seats, a flexible sealing element, and a lid. In one embodiment,
 the main body has top and bottom portions, is configured to sealingly attach to the pipe system
 proximate the bottom portion, and further defines a first chamber configured to communicate with
 the vent pipe system. The inner and outer valve seats define a vent opening that is configured to
 vent to the ambient environment. The flexible sealing element is devoid of a rigidifying structure, is
 10 configured to move between a closed position and an open position, and defines an outer
 perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending
 between the outer and inner perimeter surfaces. The lid is configured to sealingly attach to the
 main body proximate the top portion of the main body. At least one of the lid and main body
 further comprises one or more guiding elements that define one or more guiding surfaces
 15 configured to guide the sealing element to and from the closed position and the open position. In
 the closed position, the bottom surface of the sealing element rests against the inner and outer
 valve seats, thus blocking the vent opening that is vented to the ambient environment. In the open
 position, the sealing element rises off of the inner and outer valve seats such that the first chamber
 communicates with the ambient environment through the vent opening. In some embodiments,
 20 the top surface of the sealing element may include an inner support rib and an outer support rib,
 wherein the inner and outer support ribs are configured to provide support for the sealing element
 proximate the inner and outer valve seats, respectively. In other embodiments, the sealing
 member may further comprise a middle rib disposed between the inner and outer ribs.

In some embodiments, the lid may further comprise a top portion, and a side portion
 25 extending approximately perpendicularly from an outer perimeter of the top portion of the lid, the
 top and side portions of the lid each defining inner and outer surfaces such that the inner surfaces
 of the lid define a second chamber. In some embodiments, the main body may further comprise
 an approximately cylindrically-shaped main body wall defining an inner surface and an outer
 surface, the main body further defining an internal communication element that extends inwardly
 30 from the inner surface of the main body wall, and wherein the internal communication element
 comprises a plurality of openings allowing communication therethrough between the first chamber
 and the second chamber. In some embodiments, the one or more guiding elements may comprise
 a plurality of guiding elements that extend from the inner surface of the top portion of the lid. In
 other embodiments, the plurality of guiding elements may comprise a plurality of triangularly-
 35 shaped ribs extending substantially downward from the inner surface of the top portion of the lid,
 the plurality of ribs defining a plurality of guiding edges and wherein the ribs are disposed radially
 about an imaginary center point.

In some embodiments, the main body may further comprise an approximately cylindrically-
 shaped main body wall defining an inner surface and an outer surface, wherein one end of the
 40 main body wall defines the inner valve seat, and wherein the main body further defines an external

communication element that extends outwardly and at an angle from the outer surface of the main body wall such that an end of the external communication element defines the outer valve seat, wherein a third chamber is defined between the outer surface of the main body wall and the external communication element, and wherein the external communication element comprises a plurality of openings allowing communication therethrough between the third chamber and the ambient environment. In some embodiments, a plurality of support walls may be disposed within the third chamber. In other embodiments, the one or more guiding elements may comprise a plurality of guiding elements that extend from the internal communication element of the main body. In other embodiments, the plurality of guiding elements may comprise a plurality of triangularly-shaped ribs extending from the internal communication element of the main body, and wherein the ribs may be disposed radially about an imaginary center point.

In another embodiment, the air admittance valve comprises a main body made of a rigid material, a flexible ring-shaped sealing member, and a lid made of a rigid material. The main body has top and bottom portions and is configured to sealingly attach to the pipe system proximate the bottom portion and a main body chamber configured to communicate with the pipe system. The main body also comprises an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, wherein one end of the main body wall defines an inner valve seat, and wherein the main body further defines an internal communication element and an external communication element, the internal communication element extending inwardly from the inner surface of the main body wall and comprising a plurality of openings allowing communication therethrough between the main body chamber and a lid chamber, the external communication element extending outwardly and at an angle from the outer surface of the main body wall such that an end of the external communication element defines an outer valve seat. An external communication chamber is defined between the outer surface of the main body wall and the external communication element, and the external communication element comprises a plurality of openings allowing communication therethrough between the external communication chamber and the ambient environment. A vent opening is defined between the inner and outer valves seats that is configured to provide communication between the external communication chamber and the lid chamber. The flexible ring-shaped sealing element is configured to move between a closed position and an open position, and the sealing element defines an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces. The lid is made of a rigid material and is configured to sealingly attach to the main body proximate the top portion of the main body, the lid comprising a top portion, and a side portion extending approximately perpendicularly from an outer perimeter of the top portion, the top and side portions each defining inner and outer surfaces such that the inner surfaces define the lid chamber. The lid further comprises a plurality of triangularly-shaped ribs extending downward from the inner surface of the top portion of the lid and disposed radially about an imaginary center point such that the plurality of ribs define a plurality of guiding edges configured to guide the sealing element via the inner perimeter surface of the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and

outer valve seats of the main body thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the main body chamber communicates with the ambient environment through the vent opening, the lid chamber, and the external communication chamber.

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BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 shows a common application of an air admittance valve in accordance with the prior art;

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FIG. 2 is a perspective view of an assembled air admittance valve in accordance with an exemplary embodiment of the present invention;

FIG. 3 is an exploded perspective view showing a lid, a sealing member, and a main body of an air admittance valve in accordance with an exemplary embodiment of the present invention;

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FIG. 4 is a perspective view of the underside of a lid of an air admittance valve in accordance with an exemplary embodiment of the present invention;

FIG. 5 is a cross-section view of an assembled air admittance valve in a closed position in accordance with an exemplary embodiment of the present invention;

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FIG. 6 is a cross-section view of an assembled air admittance valve in an open position in accordance with an exemplary embodiment of the present invention;

FIG. 7 is an exploded perspective view showing a sealing member, a main body, and the underside of a lid of an air admittance valve in accordance with another exemplary embodiment of the present invention; and

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FIG. 8 is an exploded perspective view showing a sealing member, a main body, and the underside of a lid of the air admittance valve in accordance with yet another exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

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The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the present invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

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FIG. 1 shows a common application of an air admittance valve in accordance with the prior art. As depicted in the figure, in a common application an air admittance valve **20** communicates with a plumbing system **22** to vent the plumbing system upon the discharge of wastewater, such as from a wastewater source **24**. Although the air admittance valve **20** opens upon discharge of the wastewater, it is normally closed to prevent the escape of gases from the plumbing system. As

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noted above, many prior art air admittance valves include a rigid plate or frame structure that is used to carry a thin flexible sealing member to and from closed and open positions. However, these multipart constructions are not only difficult and expensive to manufacture, but sometimes result in poor performance due to inconsistencies in the frame structures.

5 **FIG. 2** shows a perspective view of an assembled air admittance valve **50** in accordance with an exemplary embodiment of the present invention, and **FIG. 3** shows an exploded perspective view of the air admittance valve **50** in accordance with an exemplary embodiment of the present invention. In general, the air admittance valve **50** according to various embodiments of the present invention includes a lid **60**, a flexible sealing element **70** (not visible in **FIG. 2**), and a
10 main body **80**. Referring to **FIG. 3**, in the depicted embodiment, the lid **60** is made of a rigid thermoplastic material, such as, for example, polyvinyl chloride (PVC) or acrylonitrile butadiene styrene (ABS), and comprises a top portion **62** having an outer perimeter **63**, and a side portion **64** that extends approximately perpendicularly from the outer perimeter **63** of the top portion **62**. The top portion **62** includes an outer surface **65** and an inner surface **66** (inner surface **66** is visible in
15 **FIG. 4**). Likewise, the side portion **64** includes an outer surface **67** and an inner surface **68** (inner surface **68** is visible in **FIG. 4**). It should be noted that in other embodiments, the lid may be constructed of any rigid material. Additionally, other configurations of the lid are possible, including, for example, disk-like configurations that do not include side portions. In the depicted embodiment, a lid chamber **69** is defined by the inner surfaces **66**, **68** of the lid **60** (lid chamber **69**
20 is visible in **FIG. 4**). As shown in the figure, the lid **60** has a substantially circular top profile, which is designed to sealingly attach to the main body **80**. It should be noted that in other embodiments the lid **60** and/or the main body **80** may have various other configurations and are not limited to the shapes and configurations shown in the figures. In the depicted embodiment, the lid **60** is constructed of a rigid material, and is attached to the main body **80** through the use of a sonic
25 weld. In other embodiments however, the lid **60** may be secured to the main body **80** in any other manner designed to sealingly attach the lid **60** to the main body **80**, including, but not limited to, other mechanical and/or chemical attachment methods.

 The sealing element **70** of the depicted embodiment is a ring-shaped seal constructed of a flexible material. However, it should be noted that in other embodiments, the sealing element **70**
30 could have a variety of shapes, including, for example, oblong, hourglass, and elliptical shapes. In the depicted embodiment, sealing element **70** comprises an outer perimeter surface **72**, an inner perimeter surface **74**, a top surface **76**, and a bottom surface **78**. The top and bottom surfaces **76**, **78** are configured opposite of each other and extend between the outer perimeter surface **72** and the inner perimeter surface **74**. Although not visible in **FIG. 3**, the bottom surface **78** of the sealing
35 member **70** defines a substantially planar surface in order to provide a seal for the air admittance valve **50**. In the depicted embodiment, the top surface **76** of the sealing element **70** includes an outer rib **75**, a middle rib **77**, and an inner rib **79**, wherein the ribs **75**, **77**, and **79** are substantially concentric about the center of the sealing element **70**. Although other embodiments of the present invention may not include ribs, in the depicted embodiment, the inner and outer ribs **75**, **79** provide
40 support for the sealing element in an area proximate the valve seats. In the depicted embodiment,

the sealing member **70** is a unitary element constructed of a silicone material, however in other embodiments, various other configurations and materials are possible.

Referring to **FIG. 3**, the main body **80** of the air admittance valve **50** includes a top portion **82** and a bottom portion **84**. In the depicted embodiment, the bottom portion **84** has a substantially cylindrical shape and includes a threaded section **86** proximate a distal end of the bottom portion **84**. In the depicted embodiment, the threaded section **86** of the bottom portion **84** is defined in an outer surface of the bottom portion **84** so that the air admittance valve **50** may be affixed to an internally threaded end of an existing pipe system. In other embodiments, however, the threaded section **86** could be defined by an inner surface of the bottom portion **84**, or, in still other embodiments, other methods of attaching the air admittance valve **50** to the pipe system are possible. Although other physical configurations are possible, the cylindrical shape of the bottom portion **84** allows the depicted embodiment to interface with existing pipe systems, which often comprise substantially cylindrical pipes.

The main body **80** of the air admittance valve **50** comprises an approximately cylindrically shaped main body wall **88** (seen more clearly in **FIGS. 5** and **6**) that defines an inner surface **90** and an outer surface **92**. A main body chamber **93** (seen more clearly in **FIGS. 5** and **6**) is defined by the inner surface of the main body wall **88**. Thus, in the depicted embodiment, when the air admittance valve **50** is attached to an existing pipe system, the main body chamber **93** is configured to communicate with the attached pipe system. In the depicted embodiment, the main body **80** of the air admittance valve **50** is made of a rigid thermoplastic material, such as, for example, polyvinyl chloride (PVC) or acrylonitrile butadiene styrene (ABS). It should be noted that in other embodiments, the main body **80** may be made of any rigid material. In some embodiments, such as the depicted embodiment, the material of the main body **80** may be chosen to complement the material of the lid **60**. However, in other embodiments, the lid **50** and the main body **80** may be constructed of dissimilar materials.

The top end of the main body wall **88** defines a substantially circular surface having a rounded edge, thus defining an inner valve seat **95** of the air admittance valve **50**. It should be noted that in the depicted embodiment, although the main body wall **88** has a generally cylindrical shape, it necks inward between the bottom portion **84** and the top portion **82**. In other embodiments, however, the main body wall **88** may have other configurations. Additionally, although the inner valve seat **95** of the depicted embodiment has a rounded profile, in other embodiments it could have various profiles configured to provide a seal with the sealing element **70**.

In the depicted embodiment, the top portion **82** of the air admittance valve **50** includes an external communication element **96** and an internal communication element **98**. The external communication element **96** extends outwardly and upwardly at an angle from the outer surface **92** of the main body wall **88**, and defines an external communication chamber **97** between the outer surface **92** and the external communication element **96**. The end portion **99** of the external communication element **96** also defines an outer peripheral edge **101** upon which the lid **60** is attached. An end portion **99** of the external communication element **96** defines a substantially

circular ring having a rounded edge, which defines an outer valve seat **100**. As such, in the depicted embodiment, the inner and outer valve seats **95, 100** are defined by the main body **80**. However, in other embodiments the inner and outer valve seats may be defined by various other components, and in some embodiments the inner valve seat may be defined by one component and the outer valve seat may be defined by another component. For example, in one embodiment the inner valve seat may be defined by the main body and the outer valve seat may be defined by the lid. Also, although the outer valve seat **100** of the depicted embodiment has a rounded profile, in other embodiments it could have various profiles configured to provide a seal with the sealing element **70**. Additionally, in still other embodiments, the inner valve seat **95** and the outer valve seat **100** could have different profiles.

In the depicted embodiment, the inner and outer valve seats **95, 100** are substantially concentric about the center of the main body wall **88**, substantially co-planer with each other, and there is a vent opening **102** located between the valve seats **95, 100**. As will be described in more detail below, when the air admittance valve **50** is in an open position, the vent opening **102** between the inner and outer valve seats **95, 100** is configured to allow venting through the vent opening **102**, i.e., air can flow between the lid chamber **69** and the external communication chamber **97** via the vent opening **102**. In the depicted embodiment, the external communication chamber **97** also includes a plurality of support elements **103** that extend between the outer surface **92** of the main body wall **88** and the external communication element **96**. As will be described in more detail below, in various embodiments, the plurality of support elements **103** are configured to prevent the sealing element **70** from becoming lodged in the external communication chamber **97**, thus the plurality of support elements **103** are configured to provide support for the sealing element **70** should the sealing element tend to be drawn into the external communication chamber **97** through the vent opening **102** between the valve seats **95, 100**. It should be noted that the plurality of support elements **103** are configured so as not to interfere with the ability of the valve **50** to allow communication of air through the vent opening **102** between the inner and outer valve seats **95, 100**. Thus, in the depicted embodiment, a plurality of open areas **107** are defined between the plurality of support elements **103**.

In the depicted embodiment, the external communication element **96** is comprised of a plurality of projections **104** that extend between the outer surface **92** of the main body wall **88** and the end portion **99**. As shown in the figure, the plurality of projections **104** define a plurality of openings **109** therebetween, such that the external communication element **96** allows communication of air between the ambient environment and the external communication chamber **97** through the openings **109**. As will be described in more detail below, when the air admittance valve **50** is in an open position, air enters the air admittance valve **50** through the external communication element **96**. As a result, the plurality of projections **104** act to protect the inside of the valve **50** from any debris or other materials that may tend to be carried by the air flow. It should be noted, however, in other embodiments of the present invention, other configurations of an external communication element **96** are possible. In such a manner, the openings **109** of the external communication element **96** may have other configurations, including smaller openings,

larger openings, or combinations thereof. Furthermore, in various embodiments, the external communication element **96** may have various other configurations, and in some embodiments, there need not be an external communication element **96**.

As noted above, the main body **80** also defines an internal communication element **98** that
 5 extends inwardly and upwardly from the inner surface **90** of the main body wall **88** proximate the top end **94**. In the depicted embodiment, the internal communication element **98** includes a mesh surface **110** (**FIG. 3**) that extends to a top surface **112**. The mesh surface **110** defines a plurality of openings **114**, such that the internal communication element **98** allows communication of air through the openings **114**. The mesh surface **110** acts to protect the inside of the valve **50** from
 10 any debris or other materials that may tend to be carried by the air flow, which may include various debris from the pipe system. It should be noted, however, in other embodiments of the present invention, other configurations of the internal communication element **98** are possible. In such a manner, any openings of the internal communication element **98** may have other configurations, including smaller openings, larger openings, or combinations thereof. Furthermore, in various
 15 embodiments, the internal communication element **98** may have a various other configurations, and in some embodiments, there need not be an internal communication element.

FIG. 4 shows the underside of the lid **60**. In various embodiments, one or more guiding elements may extend from the lid **60**. In the depicted embodiment, a plurality of guiding elements **105** extend from the inner surface **66** of the top portion **62** of the lid **60** into the lid chamber **69**.
 20 However, in other embodiments a single guiding element may extend from the lid **60**, such as, for example, a cylindrical element. In the depicted embodiment, the plurality of guiding elements **105** define a plurality of guiding surfaces **106** that extend downward from the inner surface **66** of the top portion **62**. As will be described in more detail below, the plurality of guiding surfaces **106** are configured to guide the sealing member **70** by the inner perimeter surface **74** of the sealing
 25 member **70** to guide it as it moves between a closed position (**FIG. 5**) and an open position (**FIG. 6**). In the depicted embodiment, the plurality of guiding elements **105** comprises a plurality of substantially triangularly-shaped ribs that are radially disposed about an imaginary center point of the lid **60**, and which define a plurality of open areas **108** therebetween such that air may be communicated within the lid chamber **69**. In the depicted embodiment, the shape of the guiding
 30 elements **105** is configured to complement the shape of the internal communication element **98**, however, in other embodiments the plurality of guiding elements **105** may have any configuration that provides a plurality of guiding surfaces **106** for guiding the sealing member **70** by the inner perimeter surface **74** of the sealing member **70** and that allow the lid **60** to be sealingly attached to the main body **80**.

35 In some embodiments, one or more guiding elements may be part of the main body **80** and may extend up from the main body **80**, rather than down from the lid **60**. An example of an embodiment showing a plurality of guiding elements **105** extending from the main body **80** is depicted in **FIG. 7**. In other embodiments, one or more guiding elements **105** may be part of the lid **60** and one or more guiding elements **105** may be part of the main body **80**. An example of
 40 such an embodiment is depicted in **FIG. 8**. In such a manner, the plurality of guiding elements **105**

includes a plurality of guiding surfaces **106** configured to guide the sealing element **70** by the inner perimeter surface **74** of the sealing element **70**.

FIG. 5 shows a cross-section view of the air admittance valve **50** in the closed position. As shown in the figure, in the closed position the sealing element **70** rests via force of gravity on the inner and outer valve seats **95, 100** of the main body **80**, thus covering the vent opening **102** between the inner and outer valve seats **95, 100**. In such a manner, although there may be air communication between the pipe system and the lid chamber **69** (through the main body chamber **93** and the internal communication element **98**), the sealing member **70** blocks communication through the vent opening **102** between the inner and outer valves seats **95, 100**. Thus, air communication between the pipe system and the ambient environment is blocked. As shown in the figure, in some embodiments the inner and outer ribs **75, 79** of the sealing element **70** may be configured to approximately line up with the inner and outer valve seats **95, 100** of the main body **80** so as to provide support via increased thickness in these areas, thus providing reinforcing support for the sealing element **70** in the areas of contact with the valve seats **95, 100**.

Additionally, in some embodiments, there may be situations where the sealing member **70** is subjected to air pressure differentials that may tend to press the sealing member **70** downward into the external communication chamber **97**. As also shown in the figure, in the depicted embodiment, the middle rib **77** of the sealing element **70** is configured to be placed in an area between the inner and outer valve seats **95, 100** and proximate the plurality of support elements **103** located in the external communication chamber **97** so as to provide support for the sealing member **70** should the sealing member **70** be pressed downward. As such, the plurality of support elements **103** of the depicted embodiment tend to keep the sealing element **70** from becoming trapped in the external communication chamber, and the middle rib **75** provides reinforcing support for the sealing element **70** in an area of contact with the support elements **103**. It should be noted that, in the depicted embodiment, the plurality of support elements **103** do not extend up to the inner and outer valve seats **95, 100** so as not to interfere with the sealing of the valve seats **95, 100**. In other embodiments, other support element designs are possible, and in still other embodiments there need not be any support elements in the external communication chamber **97**.

FIG. 6 shows a cross section view of the air admittance valve **50** in the open position. The open position is created by a negative pressure condition, which may be initiated when wastewater in the pipe system is released (such as, for example, by flushing a toilet or by draining a wastewater tub). The negative pressure condition causes the sealing element **70** to rise off of the inner and outer valve seats **95, 100**, thus opening communication of air through the vent opening **102** between the inner and outer valve seats **95, 100**. As shown in the figure, the sealing element **70** is guided into the lid chamber **69** via its inner perimeter surface **74** by the plurality of guiding surfaces **106** defined by the plurality of guiding elements **105**. Once in the open position, communication of air through the vent opening **102** between the inner and outer valve seats **95, 100** allows air to be drawn in from the ambient environment and ultimately into the pipe system. In particular, air is drawn from the ambient environment through the openings **106** of the external communication element **96** into the external communication chamber **97**, and from the external

communication chamber **97** through the vent opening **102** between the inner and outer valve seats **95, 100** and into the lid chamber **69**, and from the lid chamber **69** through the openings **114** of the internal communication element **98** and into the main body chamber **93**, which is in direct communication with the pipe system. When the negative pressure condition ceases, the sealing
5 element **70** drops down from the lid chamber **69**, again guided via its inner perimeter surface **74** by the plurality of guiding surfaces **106** defined by the plurality of guiding elements **105** and onto the inner and outer valve seats **95, 100**, thus sealing the vent opening **102** between the valve seats **95, 100**, and closing the valve **50**.

As a result, and among other reasons, the present invention improves on the prior art by
10 providing an air admittance valve **50** having a sealing element **70** that is guided to and from open and closed positions via an inner perimeter surface **74** of the sealing element **70**, and thus without the need for a separate guiding frame structure attached to the sealing member **70**. Thus, the present invention provides a simpler air admittance valve design and that provides enhanced performance that is less expensive to manufacture.

15 Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which this invention pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the
20 appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

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CLAIMS:

1. An air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising:

5 a main body having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body also defining a first chamber configured to communicate with the pipe system;

inner and outer valve seats that define at least one vent opening located between the inner and outer valve seats and configured to communicate with
10 the ambient environment;

a flexible sealing element devoid of a rigidifying structure and configured to move between a closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces;
15 and

a lid configured to sealingly attach to the main body,

wherein the lid further comprises one or more guiding elements that define one or more guiding surfaces configured to allow relative movement with a portion of the inner perimeter surface of the sealing element so as to guide the
20 sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and outer valve seats thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the first chamber communicates with the ambient environment through the vent opening.

25 2. The air admittance valve of Claim 1, wherein the lid comprises a top portion and a side portion approximately perpendicular to the top portion and extending from an outer perimeter of the top portion of the lid, the top and side

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portions of the lid each defining inner and outer surfaces such that the inner surfaces of the lid define a second chamber.

3. The air admittance valve of Claim 2, wherein the main body comprises an approximately cylindrically-shaped main body wall defining an inner surface and
5 an outer surface, the main body further defining an internal communication element that extends inwardly from the inner surface of the main body wall, and wherein the internal communication element comprises a plurality of openings allowing communication therethrough between the first chamber and the second chamber.

4. The air admittance valve of Claim 2, wherein the main body comprises
10 an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, wherein one end of the main body wall defines the inner valve seat, and wherein the main body further defines an external communication element that extends outwardly and at an angle from the outer surface of the main body wall such that an end of the external communication element defines the outer valve seat,
15 wherein a third chamber is defined between the outer surface of the main body wall and the external communication element, and wherein the external communication element comprises a plurality of openings allowing communication therethrough between the third chamber and the ambient environment.

5. The air admittance valve of Claim 2, wherein the one or more guiding
20 elements are a plurality of guiding elements that extend from the inner surface of the top portion of the lid.

6. The air admittance valve of Claim 5, wherein the plurality of guiding elements comprises a plurality of triangularly-shaped ribs extending substantially downward from the inner surface of the top portion of the lid, the plurality of ribs
25 defining a plurality of guiding edges and wherein the ribs are disposed radially about an imaginary center point.

7. The air admittance valve of Claim 4, wherein a plurality of support walls are disposed within the third chamber.

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8. The air admittance valve of Claim 1, wherein the top surface of the sealing element includes an inner support rib and an outer support rib, and wherein the inner and outer support ribs are configured to provide support for the sealing element proximate the inner and outer valve seats, respectively.

5 9. The air admittance valve of Claim 8, wherein the sealing element further comprises a middle support rib disposed between the inner and outer support ribs.

10. An air admittance valve configured when subjected to a negative pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising:

10 a main body having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body also defining a first chamber configured to communicate with the pipe system;

inner and outer valve seats that define at least one vent opening located between the inner and outer valve seats and configured to communicate with
15 the ambient environment;

a flexible, free-floating sealing element devoid of a rigidifying structure and configured to move between a closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces;
20 and

a lid configured to sealingly attach to the main body proximate the top portion of the main body,

wherein the main body further comprises one or more guiding elements that define one or more guiding surfaces configured to allow relative movement with a
25 portion of the inner perimeter surface of the sealing element so as to guide the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner and outer valve seats thus blocking

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communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the first chamber communicates with the ambient environment through the vent opening.

11. The air admittance valve of Claim 10, wherein the lid comprises a top
5 portion and a side portion approximately perpendicular to the top portion and extending from an outer perimeter of the top portion of the lid, the top and side portions of the lid each defining inner and outer surfaces such that the inner surfaces of the lid define a second chamber.

12. The air admittance valve of Claim 11, wherein the main body
10 comprises an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, the main body further defining an internal communication element that extends inwardly from the inner surface of the main body wall, and wherein the internal communication element comprises a plurality of openings allowing communication therethrough between the first chamber and the
15 second chamber.

13. The air admittance valve of Claim 11, wherein the main body comprises an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, wherein one end of the main body wall defines the inner valve seat, and wherein the main body further defines an external communication element that
20 extends outwardly and at an angle from the outer surface of the main body wall such that an end of the external communication element defines the outer valve seat, wherein a third chamber is defined between the outer surface of the main body wall and the external communication element, and wherein the external communication element comprises a plurality of openings allowing communication therethrough
25 between the third chamber and the ambient environment.

14. The air admittance valve of Claim 12, wherein the one or more guiding elements are a plurality of guiding elements that extend from the internal communication element of the main body.

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15. The air admittance valve of Claim 14, wherein the plurality of guiding elements comprises a plurality of triangularly-shaped ribs extending substantially upward from the internal communication element, and wherein the ribs are disposed radially about an imaginary center point.

5 16. The air admittance valve of Claim 11, wherein a plurality of support walls are disposed within the third chamber.

17. The air admittance valve of Claim 10, wherein the top surface of the sealing element includes an inner support rib and an outer support rib, and wherein the inner and outer support ribs are configured to provide support for the sealing
10 element proximate the inner and outer valve seats, respectively.

18. The air admittance valve of Claim 17, wherein the sealing element further comprises a middle support rib disposed between the inner and outer support ribs.

19. An air admittance valve configured when subjected to a negative
15 pressure condition to vent a pipe system to an ambient environment, said air admittance valve comprising:

a main body made of a rigid material and having top and bottom portions and configured to sealingly attach to the pipe system proximate the bottom portion, the main body comprising substantially concentric inner and outer valve
20 seats and at least one vent opening between the inner and outer valve seats and configured to communicate with the ambient environment, the main body also defining a main body chamber configured to communicate with the pipe system, wherein the main body comprises an approximately cylindrically-shaped main body wall defining an inner surface and an outer surface, wherein one end of the main
25 body wall defines the inner valve seat, and wherein the main body further defines an internal communication element and an external communication element, the internal communication element extending inwardly from the inner surface of the main body wall and comprising a plurality of openings allowing communication therethrough

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between the main body chamber and a lid chamber, the external communication element extending outwardly and at an angle from the outer surface of the main body wall such that an end of the external communication element defines the outer valve seat, and wherein an external communication chamber is defined between the outer
5 surface of the main body wall and the external communication element, the external communication element comprising a plurality of openings allowing communication therethrough between the external communication chamber and the ambient environment;

a flexible ring-shaped sealing element configured to move between a
10 closed position and an open position, the sealing element defining an outer perimeter surface, an inner perimeter surface, and opposite top and bottom surfaces extending between the outer and inner perimeter surfaces; and

a lid made of a rigid material and configured to sealingly attach to the main body proximate the top portion of the main body, the lid comprising a top
15 portion, and a side portion approximately perpendicular to the top portion and extending from an outer perimeter of the top portion of the lid, the top and side portions of the lid each defining inner and outer surfaces such that the inner surfaces of the lid define the lid chamber,

wherein the lid further comprises a plurality of triangularly-shaped ribs
20 extending substantially downward from the inner surface of the top portion of the lid and disposed radially about an imaginary center point such that the plurality of ribs define a plurality of guiding edges configured to engage the inner perimeter surface of the sealing element so as to guide the sealing element to and from the closed position, in which the bottom surface of the sealing element rests against the inner
25 and outer valve seats of the main body thus blocking communication through the vent opening, and the open position, in which the sealing element rises off of the inner and outer valve seats such that the main body chamber communicates with the ambient environment through the vent opening, the lid chamber, and the external communication chamber.

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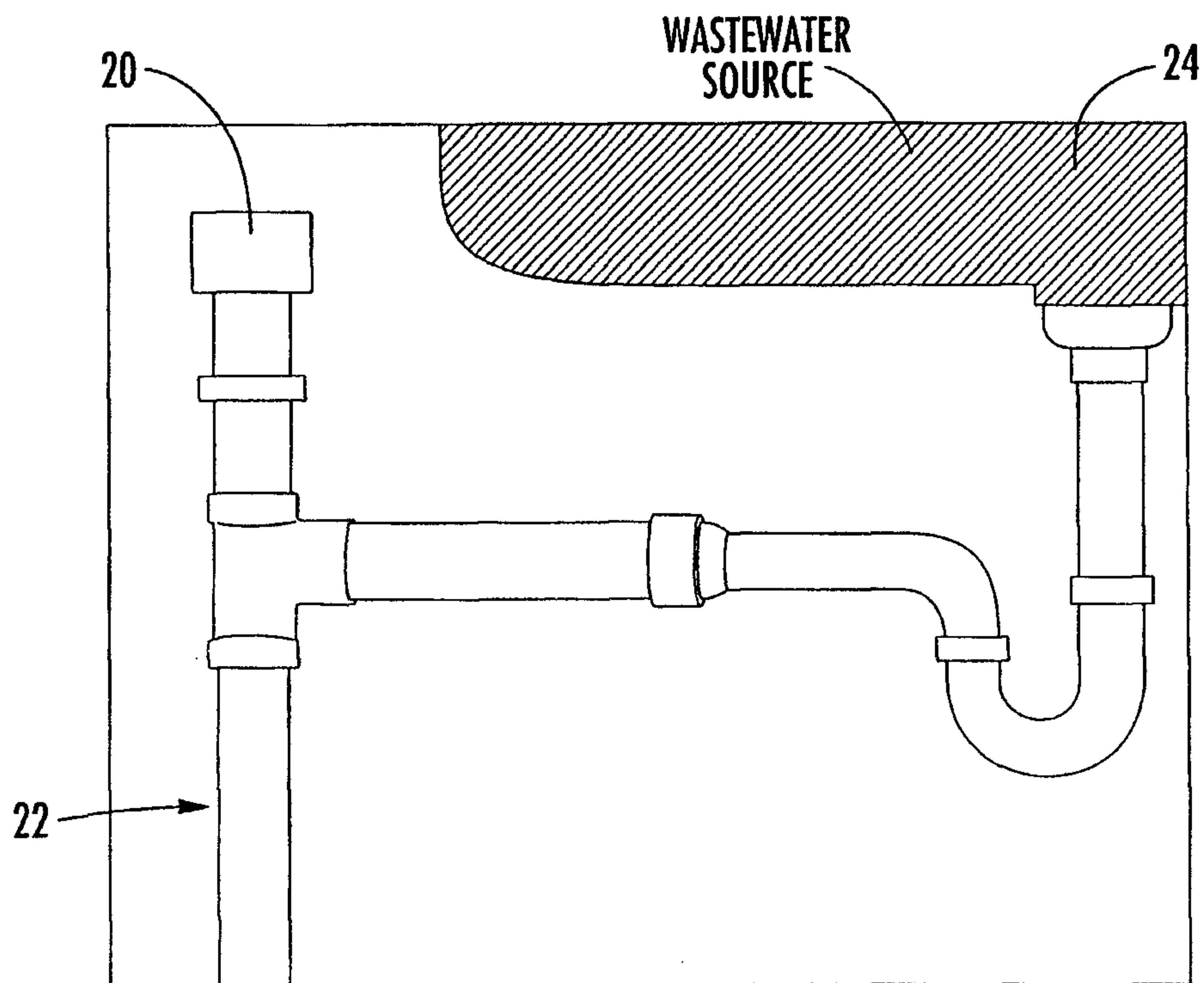


FIG. 1
(PRIOR ART)

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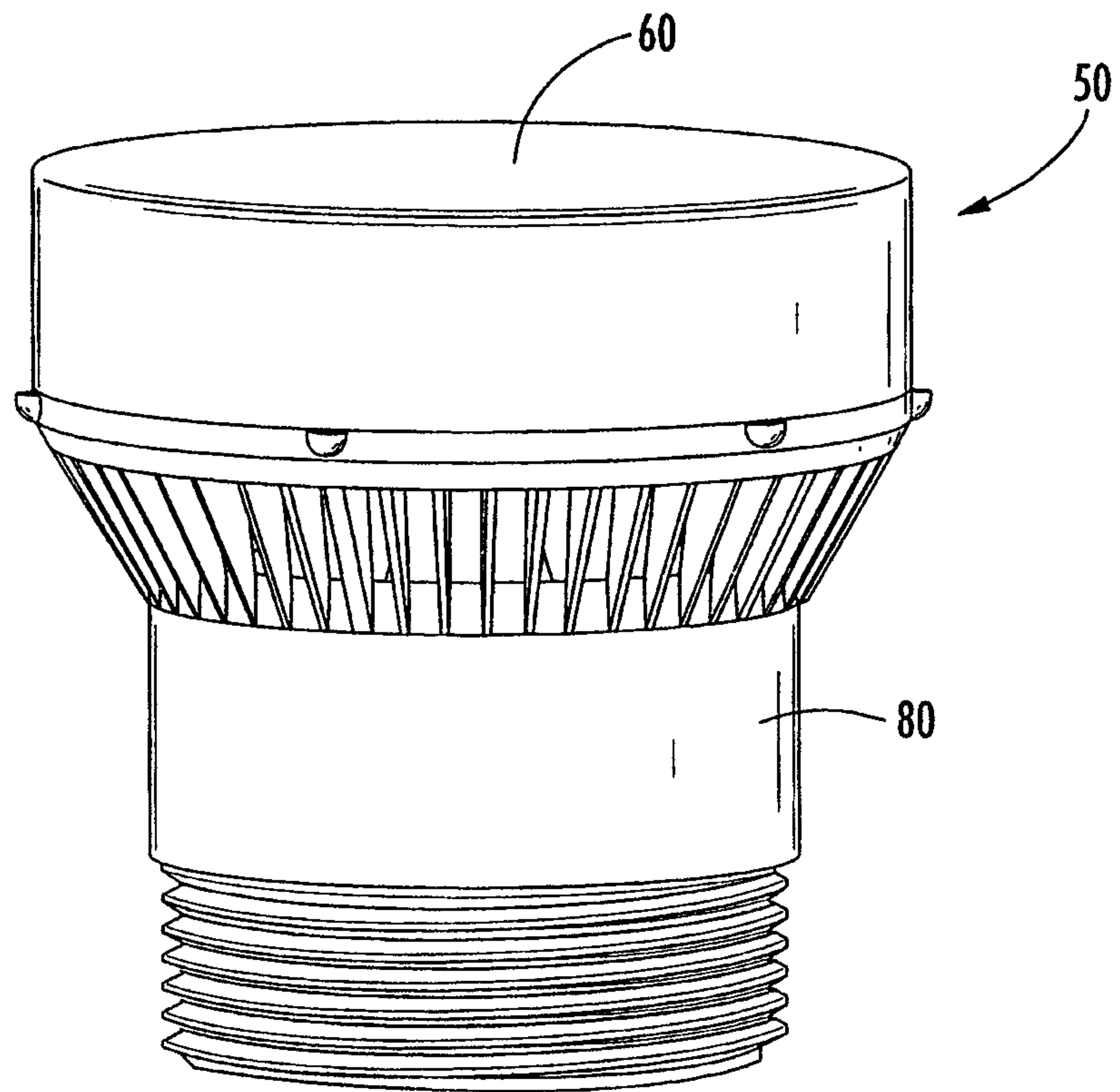


FIG. 2

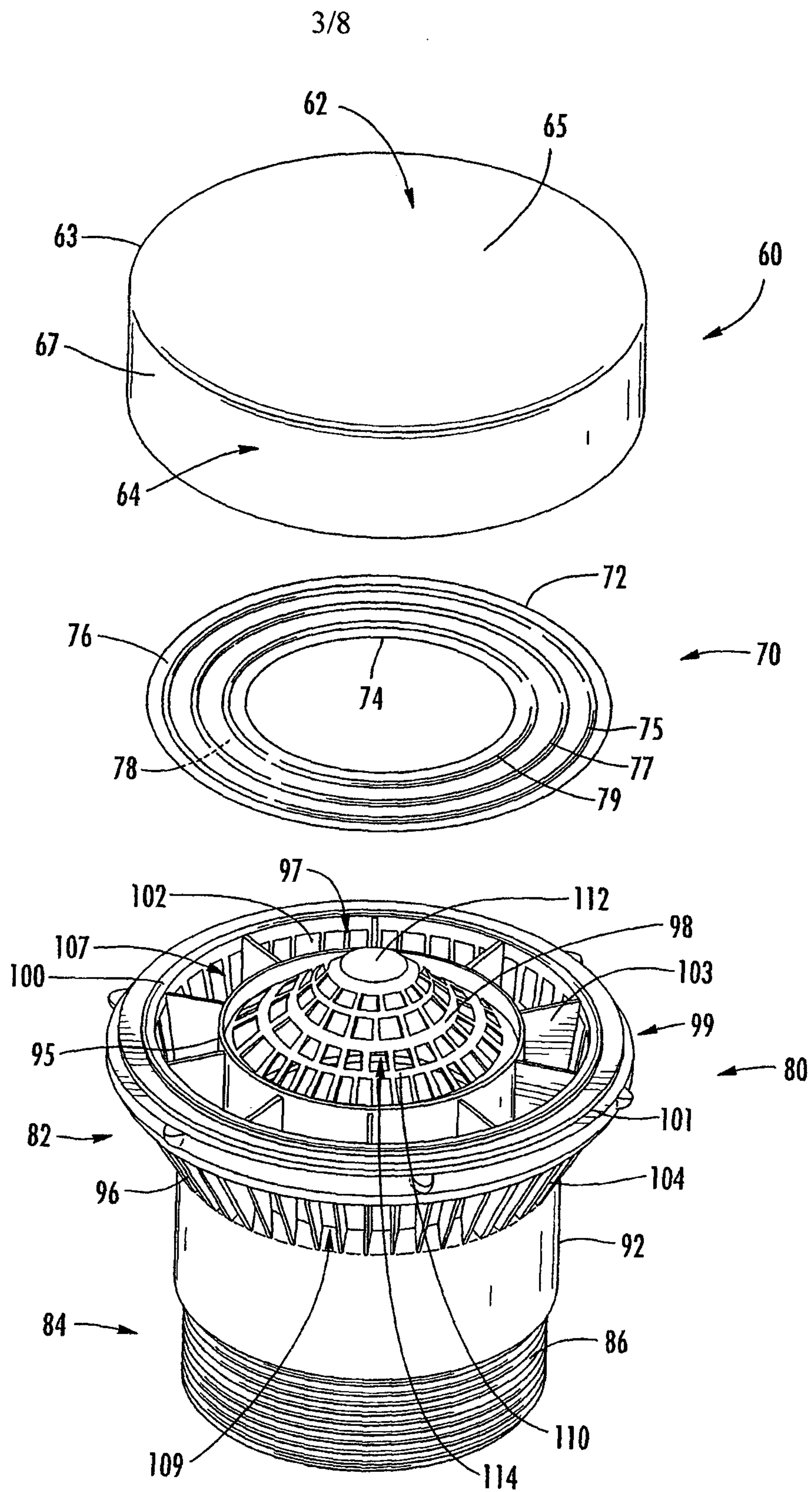


FIG. 3

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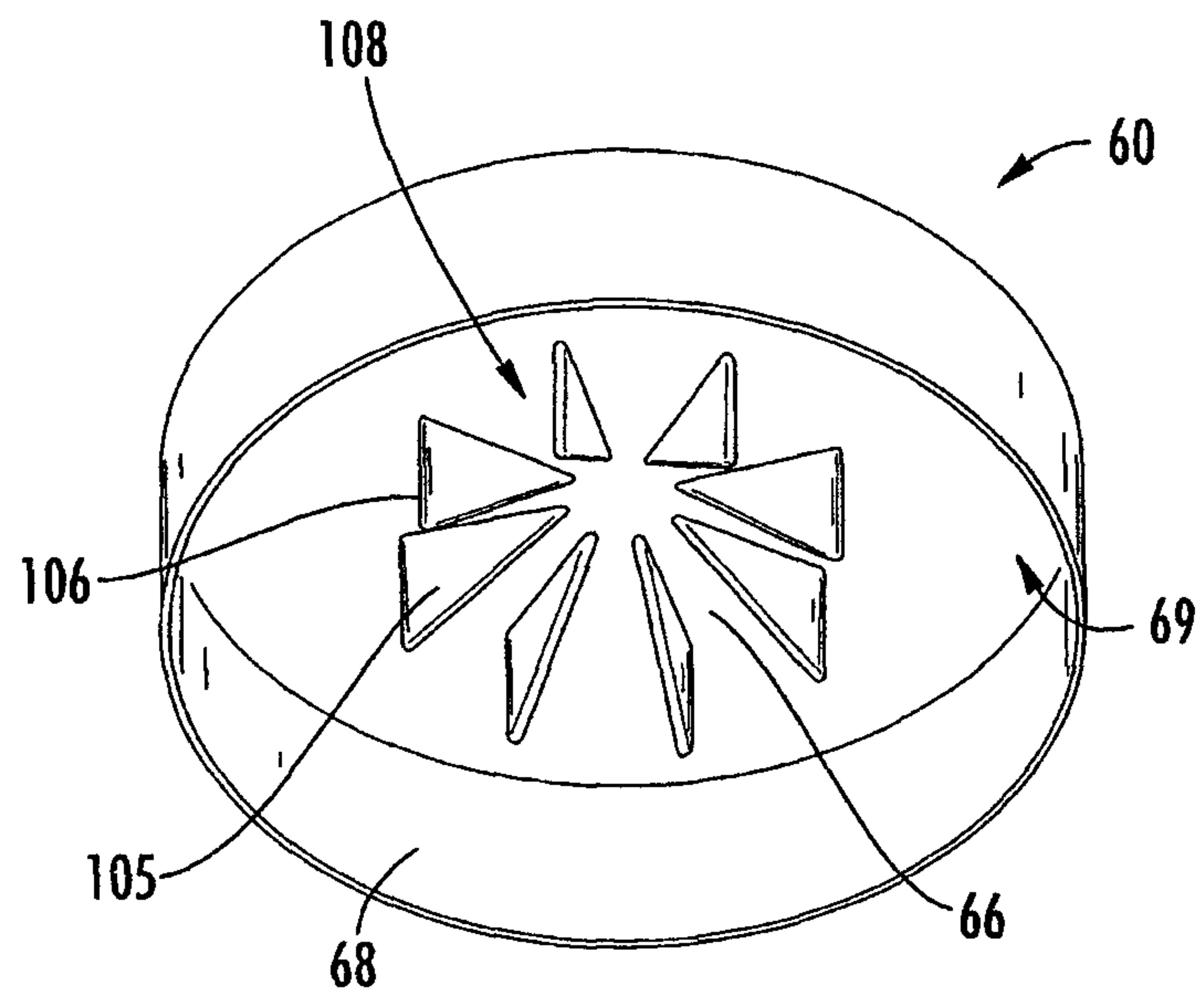


FIG. 4

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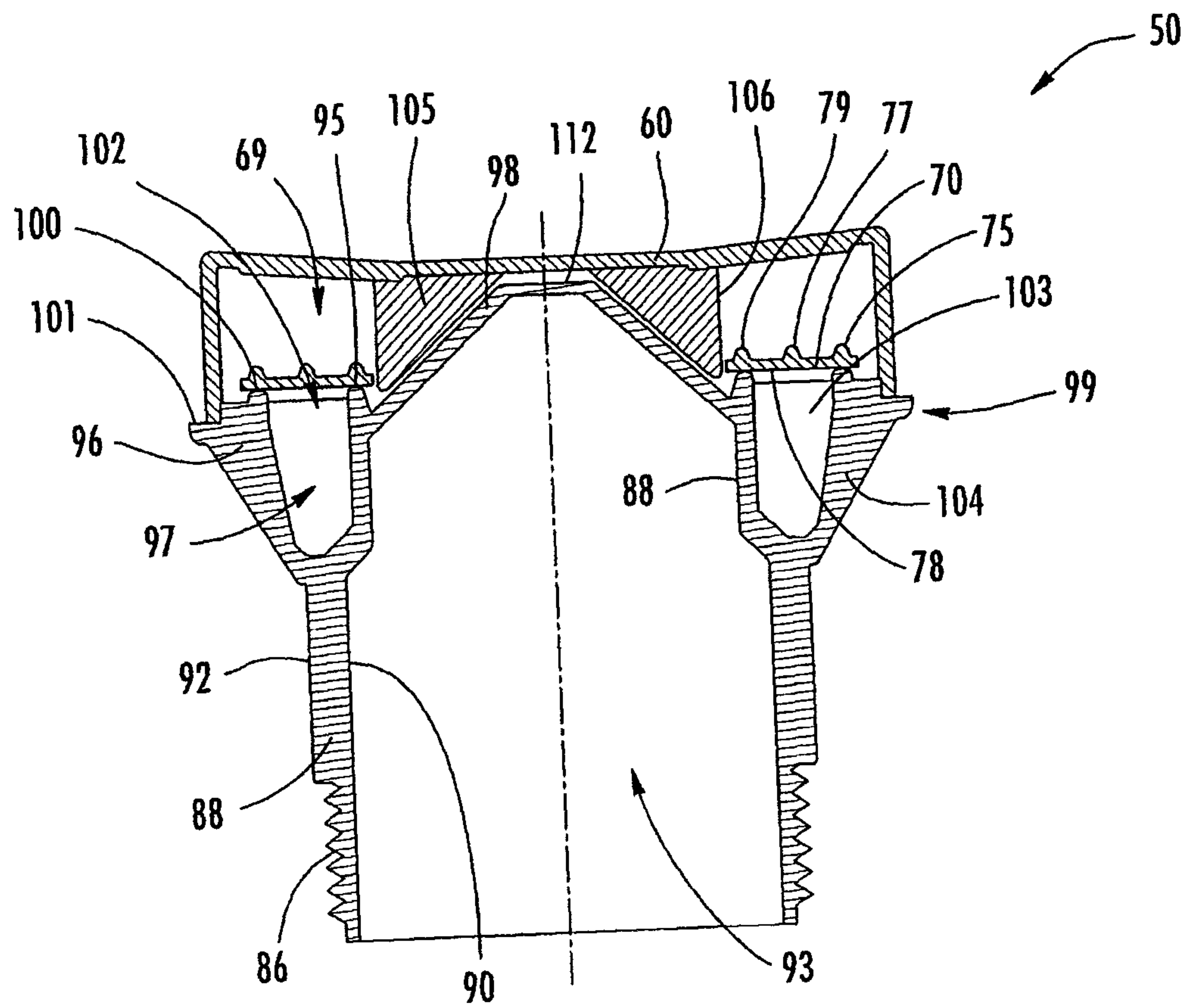


FIG. 5

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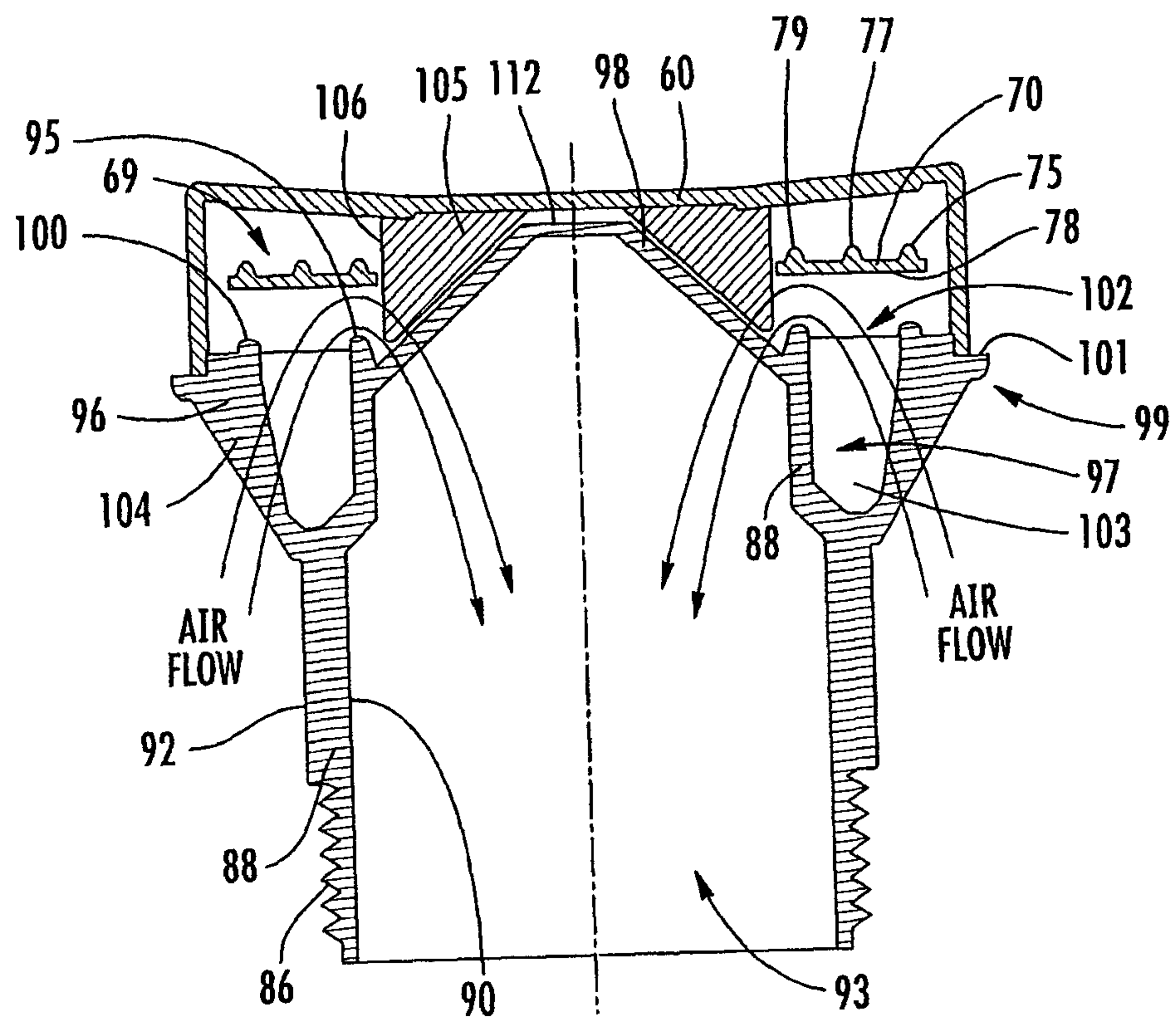


FIG. 6

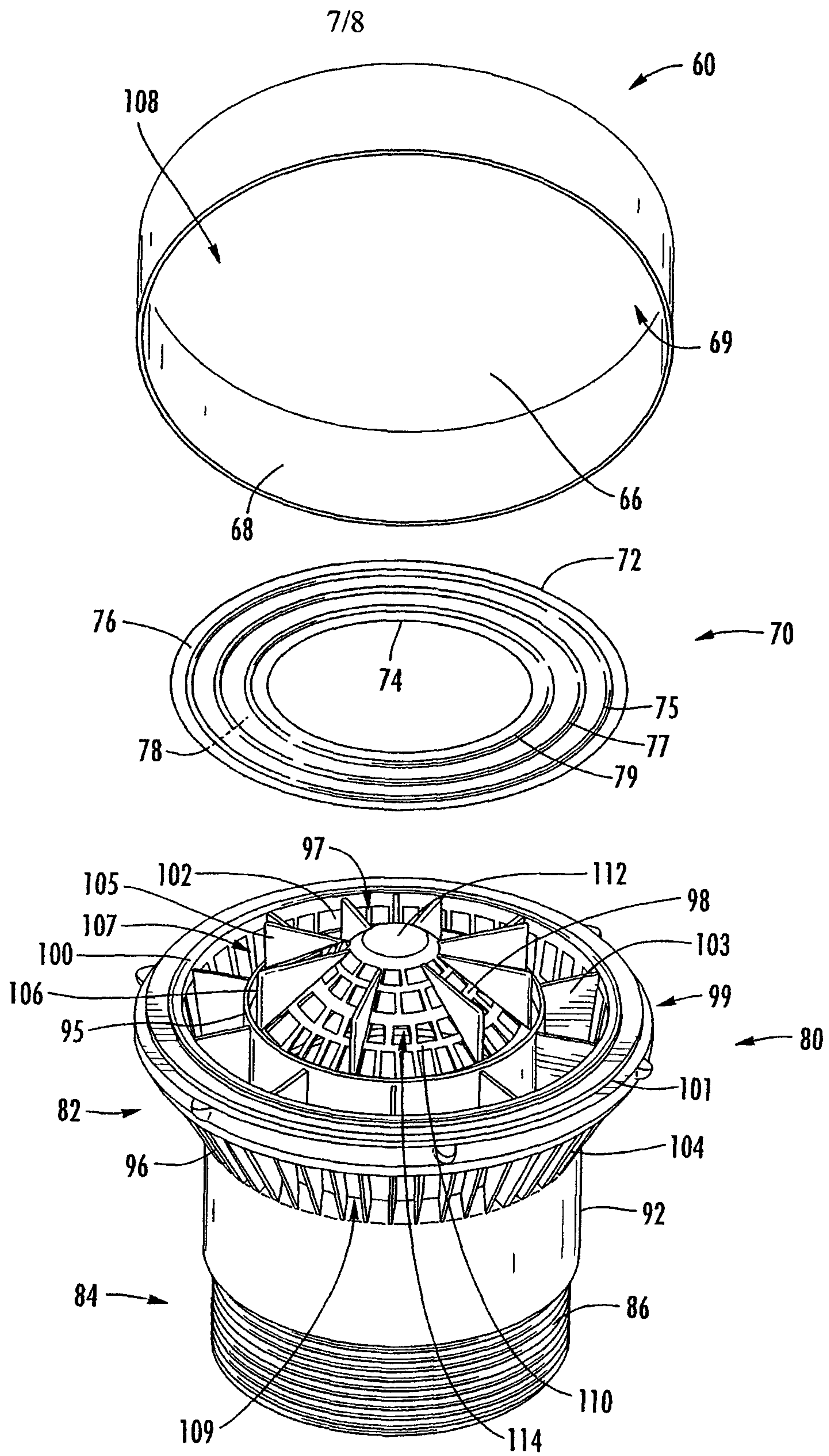


FIG. 7

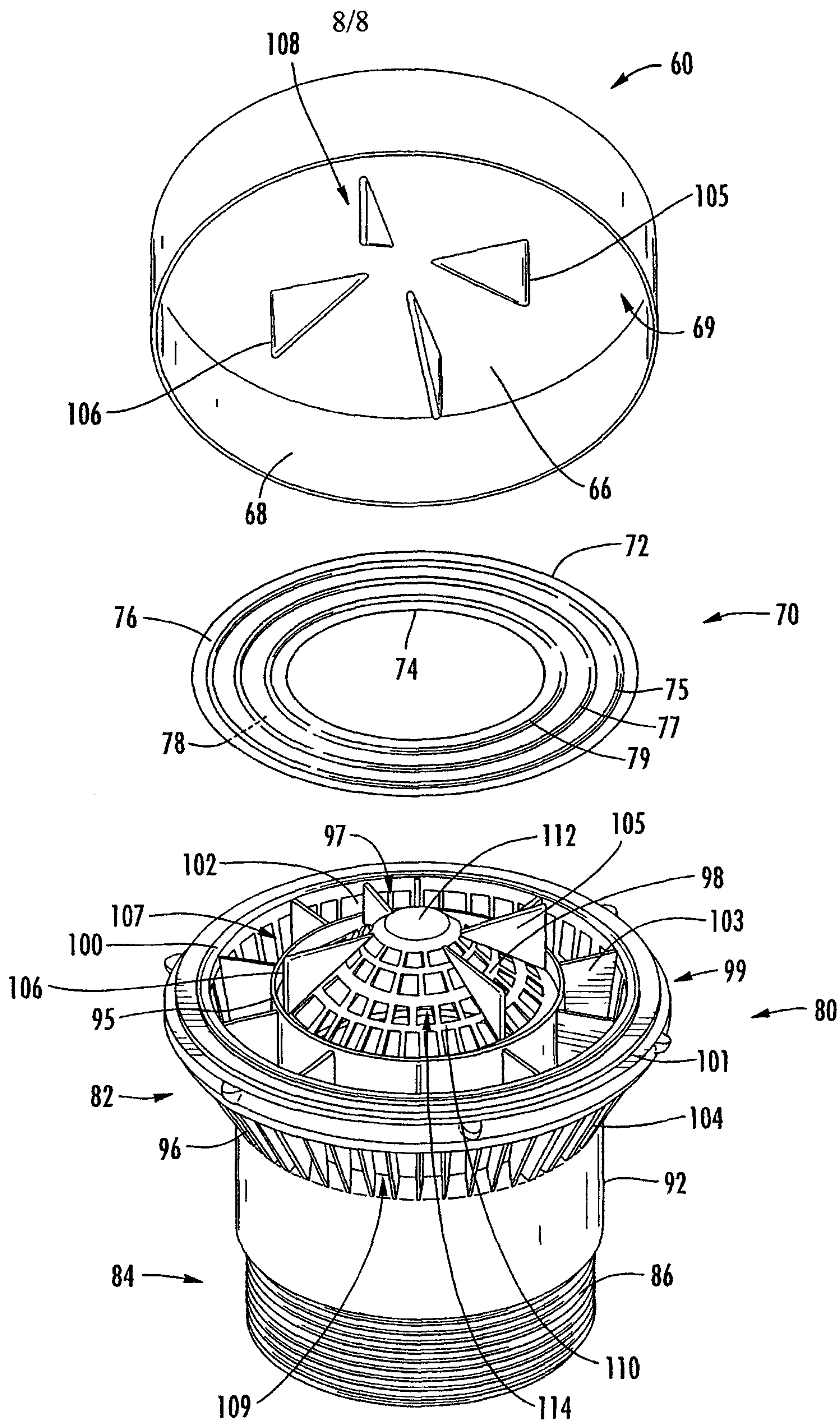


FIG. 8

